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CLINICAL RESEARCH

Risk of Thromboembolism in Shoulder Arthroplasty: Effect of Implant Type and Traumatic Indication

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Abstract

Background Prior research about symptomatic venous thromboembolism (VTE) after shoulder arthroplasty has not determined whether procedure type (hemiarthroplasty, total shoulder arthroplasty, or reverse shoulder arthroplasty) or surgical indication (traumatic or elective) represent risk factors for VTE after shoulder replacement.

Questions/purposes We therefore asked whether the risk of symptomatic VTE events and mortality within 90 days of shoulder arthroplasty was influenced by (1) procedure type, and (2) surgical indication (traumatic or elective).

Methods We performed a retrospective database review of symptomatic VTE events and mortality within 90 days of shoulder arthroplasty in a large (30-hospital) integrated healthcare system over a 5-year period, from January 2005 to December 2009. We compared the likelihood of VTE and death in patients undergoing reverse shoulder arthroplasties (RSAs), total shoulder arthroplasties (TSAs), and hemiarthroplasties (HAs), and we compared the likelihood of VTE and death in patients who underwent elective shoulder arthroplasties with those who underwent shoulder arthroplasty in the setting of acute trauma.

Results In the 2574 eligible shoulder arthroplasties identified during the study period, VTE developed in 1.01% of patients (deep vein thrombosis 0.51% and pulmonary embolism 0.54%). With the numbers available, no differences were observed in rates of VTE or mortality by procedure type. A trend toward increased VTE occurred more frequently in patients having surgery for traumatic indications than after elective surgery (1.71% versus 0.80%; $p = 0.055$). A higher likelihood of 90-day mortality was observed in trauma patients compared with elective (odds ratio = 7.4; 95% CI, 2.4–25.2).

Conclusions VTE occurred infrequently in this study sample. These data support future risk and benefit assessment of routine pharmacologic VTE prophylaxis in the perioperative treatment of patients undergoing shoulder arthroplasty, especially in all RSA and traumatic HA subsets, where the risk of VTE may be higher.

Level of Evidence Level II, prognostic study. See Instructions for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that waiver of informed consent for the study was obtained from the Institutional Review Board.
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Introduction

Although venous thromboembolic (VTE) disease has been researched extensively and discussed in hip and knee arthroplasties [6, 8, 10], the phenomenon has not been as well described after shoulder surgery. Deep vein thrombosis (DVT) and pulmonary embolism (PE) are potential complications of shoulder procedures such as arthroscopy and closed reductions of the shoulder [2, 11, 14]. Patients having open shoulder procedures including hemiarthroplasty (HA) and total shoulder arthroplasty (TSA) may be even more prone to VTE because of increased dissection, extreme arm positioning, and blood loss [1, 7, 12, 13, 15]. In addition, arm positioning during shoulder arthroplasty may put increased tension on the brachial plexus, and, by extension, the associated vascular tree [9].

Although studies regarding VTE incidence in shoulder arthroplasty have described rates [7, 13, 15] and analyzed perioperative risk factors [1, 7], no study has determined whether implant type or the surgical indication (elective versus traumatic) is associated with a change in frequency of VTE events after shoulder arthroplasty. The question is important because there may be at-risk subpopulations of patients having shoulder arthroplasty that would benefit from more aggressive approaches to thromboprophylaxis.

We therefore asked whether risk of symptomatic VTE events and mortality within 90 days of shoulder arthroplasty was influenced by (1) procedure type, and (2) surgical indication (traumatic or elective).

Patients and Methods

We performed a retrospective cohort study of shoulder arthroplasty procedures and incidence of symptomatic postoperative VTE events and 90-day mortality in a large integrated healthcare system. This methodology has been used to describe the incidence of symptomatic VTE after other elective orthopaedic procedures in the same integrated healthcare system [8]. Between January 2005 and December 2009, 30 medical centers performed shoulder arthroplasties. The study sample was identified using the healthcare system's electronic health record (EHR) system with ICD-9-CM procedure codes, including TSA, reverse shoulder arthroplasty (RSA) (both ICD-9-CM 81.80), and HA (ICD-9-CM 81.81). A trained clinical content expert (MFB), who is a master's level research colleague with a degree in a health-related field and training in the clinical definitions used in this study, reviewed the patients' EHRs after initial identification of the procedures. Characteristics of the patients and procedures were extracted from the operative reports that had been reviewed by the clinical content expert.

Table 1. Shoulder arthroplasty sample characteristics, procedure, and procedure indication

Variable	Number of patients (%)
Total	2574
Female	1448 (56.3)
Operative side	
Left	1100 (42.7)
Right	1474 (57.3)
Case type	
Elective	1988 (77.2)
Trauma	586 (22.8)
Procedure type	
Total shoulder arthroplasty	1153 (44.8)
Reverse total shoulder arthroplasty	235 (9.1)
Hemiarthroplasty	1186 (46.1)
Procedure details	
Elective total shoulder arthroplasty	1130 (43.9)
Elective reverse shoulder arthroplasty	212 (8.2)
Elective hemiarthroplasty	646 (25.1)
Traumatic total shoulder arthroplasty	23 (0.89)
Traumatic reverse shoulder arthroplasty	23 (0.89)
Traumatic hemiarthroplasty	540 (21.0)
Age (years)*	69.2 (68.8–69.6)

* Values are expressed as mean, with 95% CI in parentheses.

After initial review, we excluded patients who had history of DVT or PE (identified using ICD-9-CM V12.51), patients who had received prophylactic medication for thrombotic events within 2 weeks before the procedure date or at the date of the procedures (identified by using their pharmacy records on whether anticoagulants were prescribed to the patient, therapeutic drug class 12035), and patients who we did not have at least 90 days' followup from the study sample. The study cohort included 2574 patients, 56% (n = 1448) were female, and the average age was 69 years (95% CI, 69–70 years) (Table 1).

Of the procedures, 1153 (45%) were TSAs, 233 (9%) were RSAs, and 1186 were HAs (46%). No patients were lost to followup during the study period. We obtained institutional review board approval before initiation of this study.

After the patient sample was identified, postoperative DVT and PE events were identified using the organization's comprehensive EHR through an electronic screening algorithm using ICD-9-CM diagnostic codes used by the Agency for Healthcare Research and Quality Patient Safety Indicators [3], Doppler examination orders, postoperative prescription of anticoagulants, and review of death records for possible fatal VTE events. Since routine postoperative screening was not performed, only symptomatic VTE events and those events presenting with obvious physical findings would likely have been detected. Diagnostic codes

and Doppler orders were reviewed up to 120 days postoperatively, while prescriptions for anticoagulants were reviewed up to 90 days after index surgery. Although 120 days was used as the search criterion, events were considered related to the procedure only if they were within 90 days of the index procedure. We obtained 90-day mortality from the integrated healthcare system membership and mortality database, which maintains the most current membership and vitality records from a combination of data sources: in-house mortality, direct family member-reported mortality, Social Security Administration records, and county death records.

All charts that documented a VTE event or a death were reviewed manually by a clinical content expert to confirm the event. The cause of death also was obtained when reviewing the charts for death records.

The EHR also was used to obtain patient demographic information (age, sex) and procedure-related information (surgeon, location, operative side). Using the EHR operative reports, the clinical content experts categorized TSA procedure, implant type, and presence of traumatic versus nontraumatic events. Traumatic shoulder arthroplasties are those performed due to proximal humeral fracture, usually within 1 week of the initial fracture. HA procedures were categorized into elective versus nonelective procedures and traumatic versus nontraumatic events. Only 2% of the 1153 TSAs (n = 23) were performed for trauma, while 46% of the 1186 HA procedures (n = 540) were performed for trauma.

We describe frequencies and proportions for sex, procedure code, procedure type, and trauma status by outcome of VTE, DVT, PE, and 90-day mortality. We used the chi-square test or Fisher's exact test to compare the different proportion of events in each categorical variable. Means and SDs for age by each outcome status also were calculated. We used Mann-Whitney tests to compare the age between each outcome group and the patients without events. To test the association of procedure type, sex, age, procedure code, trauma status, regional location, and each of the outcomes of interest, a univariate logistic regression model was created. Odds ratio (OR) and 95% CI are reported for the associations. All reported p values are two-sided and are considered to indicate statistical significance if less than 0.05. We performed all analyses using the SPSS® software package (SPSS® for Windows® Release 14.0.0; SPSS Inc, Chicago, IL, USA).

Results

Of the 2574 patients in the study cohort, there were 14 (0.54%; 95% CI, 0.26%–0.83%) confirmed PEs, 13 (0.51%; 95% CI, 0.23%–0.78%) DVTs, and 13 (0.51%; 95% CI, 0.23–0.78%) deaths within 90 days. Of the 13 patients with DVTs, there were six with ipsilateral upper-extremity DVTs (two cephalic, one basilic, three brachial), one contralateral upper-extremity DVT (brachial), three ipsilateral lower-extremity DVTs (one gastrocnemius, one popliteal, one specific ipsilateral lower-extremity site unknown), and three contralateral lower-extremity DVTs (one common/popliteal, two specific contralateral lower-extremity site unknown) (Table 2).

Table 2. Occurrence of ipsilateral and contralateral DVTs after shoulder arthroplasty

Location	Number of DVTs		
	Upper	Lower	Total
Ipsilateral	6	3	9
Contralateral	1	3	4
Total	7	6	13

DVT = deep vein thrombosis.

No statistically significant associations between procedure type and odds of PE, DVT, VTE (combination of DVT and PE), or 90-day mortality were observed. After RSA, 1.28% of patients sustained a PE (n = 3), 0.85% had DVT (n = 2), and 0.85% died within 90 days (n = 2) but with the numbers available these rates are not statistically significantly different from the TSA and HA groups (Table 3).

No significant associations between surgery indication (traumatic versus elective) and odds of DVT, PE, or VTE were observed either. DVT occurred in 0.85% (n = 5) of patients with trauma, PEs in 1.02% (n = 6), and 1.54% (n = 9) of the patients with trauma who died within 90 days. VTE was higher in patients who underwent traumatic (1.71%) procedures compared with elective (0.80%); this difference approached statistical significance (p = 0.055). A 7.4 (95% CI 2.4–25.2) higher likelihood of 90-day mortality was observed in patients with trauma compared with patients who had elective surgery (Table 3). In a subgroup analysis of procedure type and indication, no associations between trauma and surgery indication was found with PE, DVT, and VTE, but the likelihood of a patient with traumatic HA to die was found to be 8.5 (95% CI, 1.8–40.1; p = 0.009) times higher than a traditional TSA, and also significantly higher than an elective HA (OR = 10.9; 95% CI, 1.4–86.6; p = 0.023). Of the 13 deaths occurring in the 90-day postoperative surveillance period, only one was attributable to complications related to PE.

Discussion

Prior research investigating variables associated with symptomatic VTE after shoulder arthroplasty has not assessed the effect of factors such as the type of

Table 3. Incidence of 90-day postoperative complications by patient characteristics, procedure type, and procedure indication

Variable	Number of patients (%) (95% CI)			
	VTE	PE	DVT	Mortality
Total	26 (1.01) (0.62, 1.40)	14 (0.54) (0.26, 0.83)	13 (0.51) (0.23, 0.78)	13 (0.51) (0.23, 0.78)
Sex				
Female	14 (0.97) (0.46, 1.47)	8 (0.55) (0.17, 0.93)	7 (0.48) (0.13, 0.84)	5 (0.35) (0.04, 0.65)
Male	12 (1.07) (0.47, 1.67)	6 (0.53) (0.11, 0.96)	6 (0.53) (0.11, 0.96)	8 (0.71) (0.22, 1.20)
Operative side				
Left	12 (1.09) (0.48, 1.70)	5 (0.45) (0.06, 0.85)	7 (0.64) (0.17, 1.11)	6 (0.55) (0.11, 0.98)
Right	14 (0.95) (0.45, 1.44)	9 (0.61) (0.21, 1.01)	6 (0.41) (0.08, 0.73)	7 (0.47) (0.12, 0.83)
Case type				
Elective	16 (0.80) (0.41, 1.20)	8 (0.40) (0.12, 0.68)	8 (0.40) (0.12, 0.68)	4 (0.20) (0.00, 0.40)
Trauma	10 (1.71) (0.66, 2.76)	6 (1.02) (0.21, 1.84)	5 (0.85) (0.11, 1.60)	9 (1.54) (0.54, 2.53)
Procedure type				
Total shoulder arthroplasty	11 (0.95) (0.39, 1.52)	5 (0.43) (0.05, 0.81)	6 (0.52) (0.11, 0.94)	2 (0.17) (0.00, 0.41)
Reverse total shoulder arthroplasty	5 (2.13) (0.28, 3.97)	3 (1.28) (0.00, 2.71)	2 (0.85) (0.00, 2.03)	2 (0.85) (0.00, 2.03)
Hemiarthroplasty	10 (0.84) (0.32, 1.36)	6 (0.51) (0.10, 0.91)	5 (0.42) (0.05, 0.79)	9 (0.76) (0.26, 1.25)
Procedure details				
Elective total shoulder arthroplasty	11 (0.97) (0.40, 1.55)	5 (0.44) (0.06, 0.83)	6 (0.53) (0.11, 0.95)	2 (0.18) (0.00, 0.42)
Elective reverse shoulder arthroplasty	4 (1.89) (0.06, 3.72)	3 (1.42) (0.00, 3.01)	1 (0.47) (0.00, 1.39)	1 (0.47) (0.00, 1.39)
Elective hemiarthroplasty	1 (0.15) (0.00, 0.46)	0 (0.00) (0.00, 0.00)	1 (0.15) (0.00, 0.46)	1 (0.15) (0.00, 0.46)
Traumatic total shoulder arthroplasty	0 (0.00) (0.00, 0.00)	0 (0.00) (0.00, 0.00)	0 (0.00) (0.00, 0.00)	0 (0.00) (0.00, 0.00)
Traumatic reverse shoulder arthroplasty	1 (4.35) (0.00, 12.68)	0 (0.00) (0.00, 0.00)	1 (4.35) (0.00, 12.68)	1 (4.35) (0.00, 12.68)
Traumatic hemiarthroplasty	9 (1.67) (0.59, 2.75)	6 (1.11) (0.23, 2.00)	4 (0.74) (0.02, 1.46)	8 (1.48) (0.46, 2.50)
Age (years)*	72.3 (67.8–76.7)	73.9 (68.8–79.1)	71.6 (63.4–78.8)	75.1 (66.9–83.3)

* Values are expressed as mean, with 95% CI in parentheses; age given is by 90-day postoperative complications; VTE = venous thromboembolism; PE = pulmonary embolism; DVT = deep vein thrombosis.

reconstruction performed, and whether the reconstruction was performed electively or for a traumatic indication. The question is important because there may be at-risk subpopulations of patients undergoing shoulder arthroplasty who would benefit from more aggressive approaches to thromboprophylaxis. We identified whether incidence of symptomatic VTE events and mortality within 90 days of shoulder arthroplasty procedures was influenced by these factors. No statistically significant associations between procedure type or surgery indication and odds of PE, DVT, VTE, or 90-day mortality were observed.

This study has several limitations. First, we did not screen (with ultrasound, venography, or CT) the patients in this retrospective study, either before or after the surgery; without such screening, it is possible that some patients with preoperative DVT or PE were included. We addressed this limitation by excluding any patients from our sample who had a previous history of DVT or PE or were currently taking chemoprophylaxis for a VTE-related condition. In addition, since postoperative imaging on every one of these patients is not fiscally responsible for our organization given the low overall incidence rate, we are limited to describing only the symptomatic cases of VTE in this sample. The American Academy of Orthopaedic Surgeons recently strongly recommended against routine postoperative duplex ultrasonography screening of patients who undergo elective hip or knee arthroplasty in their Clinical Practice Guideline on preventing VTE in elective hip and knee arthroplasty, and the risk of VTE is greater in those groups than in shoulder arthroplasty [4]. Second, we were unable to evaluate the associations of many risk factors and incidence of VTE, and their confounding interrelationship. We present only bivariate associations, as the overall small number of reported VTE events limits the type of analysis that can be done. We attempted to focus our first evaluation of this cohort on what we believed may be the strongest independent risk factors of these events. Third, the incidence of DVT is probably higher than we reported, as many patients with VTE are asymptomatic. In light of this, we consider the numbers presented here as best-case estimates of the risk of VTE in this sample. Fourth, although the study sample size is large, owing to the relatively low frequency of these events, it still may be underpowered to detect the 0.9% observed difference in VTE and mortality

rates between elective and traumatic arthroplasties. Ambulatory status and time since injury potentially could influence VTE risk.

Lyman et al. [7] showed no difference in the risk of DVT or PE between 13,759 patients who had HA or TSA, however the risk of all causes of death during the hospital admission was less in patients who had TSAs than in patients who had HA ($p < 0.01$). Sperling and Cofield [13] retrospectively reviewed 2885 consecutive patients undergoing primary shoulder arthroplasty during a 20-year period. They described four PEs after HA and only one after TSA in 2885 consecutive patients undergoing primary shoulder arthroplasty during a 20-year period. Jameson et al. described VTE in 12,358 shoulder arthroplasties in the English National Health System [5]. The rates of PE, DVT, and VTE were low in TSA and in HA. In all three studies, RSA was not included.

Lyman et al. [7] showed that traumatic indication (eg, fracture or dislocation) was associated with increased risk of thromboembolic events after shoulder arthroplasties. Only two of the five PEs had an acute traumatic indication as reported by Sperling and Cofield's study [13]. Jameson et al. reported higher VTE rates in traumatic HA than in elective HA or TSA without major clinical significance (all lower than 1%) [5].

Our study has several strengths. It is the largest cohort to date reporting on symptomatic VTE events in a shoulder arthroplasty sample using a comprehensive algorithm described in another study [11], that not only reviews ICD-9CM diagnostic codes but uses medication prescription, imaging services, and chart review to ascertain cases. We used our integrated healthcare system EHR to identify procedures performed in at least 30 different medical centers. We were able to stratify procedures in this large cohort into greater detail not normally provided by studies using administrative datasets. We chart-reviewed all positive cases. This includes stratification of RSAs from the TSAs and ascertainment of elective or traumatic diagnosis that does not rely on ICD-9CM codes alone. Although detection was limited to symptomatic cases alone, which can under-represent the true rate (asymptomatic and symptomatic combined), the electronic screening algorithm allowed for acquisition of patients who otherwise might not have been found and provided clinically actionable information on subset types of patients with shoulder arthroplasties. In addition, complete followup of the cohort was obtained for the 90-day surveillance period of the study.

Our study concurs with previously published data that DVT and PE are complications of shoulder arthroplasty with a low occurrence rate [5, 7, 15]. Our study showed an overall incidence of 0.51% for symptomatic DVT and 0.54% for symptomatic PE for all patients with primary shoulder arthroplasties. Furthermore, this is the first study to compare the incidence of symptomatic DVT and PE in elective versus traumatic subsets of patients with different types of shoulder arthroplasties. Our data may be considered hypothesis-generating and useful for sample-size calculations in future prospective studies regarding routine VTE prophylaxis in the shoulder arthroplasty population.

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